

REMARKS

By this Response, claims 1 and 12 have been amended. No new matter has been entered. Claims 6 and 7 have been previously cancelled. Claims 17-20 have been previously withdrawn. No further claims have been added or cancelled. Claims 1-5 and 8-20 are pending.

Applicants respectfully request that the Examiner contact Applicants' representatives, Timothy Hsieh and Barbara Fisher, at 703-917-0000 prior to issuance of an Office Action to schedule an examiner interview. Applicants believe that additional discussions or information can expedite resolution of any outstanding issues and advance the prosecution of the instant application.

Rejection of Claims 1-3 and 8-10 Under 35 U.S.C. § 103(a)

In the Office Action, the Examiner rejected claims 1-3 and 8-10 under 35 U.S.C. § 103(a) as being unpatentable over *Mizushima et al.* (U.S. Patent No. 6,713,359) in view of *Applicant Admitted Prior Art (AAPA)*. This rejection is respectfully traversed.

The subject matter of claim 1 is directed to a method for forming MOSFETs comprising: providing a semiconductor substrate having a source region, a channel region, and a drain region, wherein the channel region resides between the source and drain regions and a gate region resides over the channel region of the substrate; forming a silicon-germanium layer within said substrate in each of the source and drain regions in the substrate and below a plane defined by an uppermost surface of the substrate, the silicon-germanium layer configured to exert a compressive stress in the channel region of the substrate; forming a silicon layer outwardly from said substrate

and the silicon-germanium layer in each of the source and drain regions; and forming a silicide layer in each of the source and drain regions.

It is the Examiner's position that *Mizushima et al.* show providing a substrate having a source region, a channel region between the source and drain regions, and a gate region over the channel region of the substrate. It is further the Examiner's position that *Mizushima et al.* disclose forming a silicon-germanium layer (18) in each of the source and drain regions in the substrate, referring to Fig. 2A, col. 6, lines 20-45 thereof. The Examiner additionally asserts that *Mizushima et al.* teach forming a silicon (19) layer outwardly from the silicon-germanium layer (18) in each of the source and drain regions (col. 6, lines 43-55) and describe forming a silicide layer (20) in each of the source and drain regions, referring to col. 6, lines 55-67, col. 7, lines 1-4 thereof. The Examiner acknowledges that *Mizushima et al.* are silent about the silicon-germanium configured to exert a compressive stress in the channel region of the substrate, however, it is the Examiner's position that AAPA is utilizing the silicon-germanium layers to introduce compressive stress in the channel region of the substrate, referring to page 2 of the specification.

In order to simplify this response, and in view of the lengthy prosecution on the same matters, it is respectfully submitted that the primary point of contention in the present rejections surrounds the issue of a position of the silicon-germanium layer with respect to the substrate. Applicants now specifically claim the position of the silicon-germanium layer to be below a plane defined by an uppermost surface of the substrate. In other words, as seen in the drawing FIGs. 1A through 1D and described in the specification at least at page 5, lines 29-31, the silicon-germanium layer is clearly in

and/or within the substrate in each of the source and drain regions. In an effort to remove any point of contradiction, the claims have been amended as described above to further define the term "within".

Turning now to the Examiner's rejection specific to this feature, it is apparently the Examiner's position that the term "on" is the same as the term "within". The Examiner points the Applicants to column 6, lines 20-45 and Figure 2A of *Mizushima et al.* as supporting the proposition that the silicon-germanium layer 18 thereof is **within** the substrate 11. To the contrary, the words "within" or "in" are not found in that portion of the specification or figure identified by the Examiner. Instead, the word "on" appears at least twice in reference to the positioning of the silicon-germanium film 18 **on** the regions 15 forming the source/drain diffusion regions. Likewise, a careful examination of Figure 2A fails to show any portion of silicon-germanium film 18 other than "on" the regions 15 formed in the substrate 11. The Examiner is correct that the source/drain regions 15 of *Mizushima et al.* are "within" the substrate 11, however, the silicon-germanium layer clearly is NOT "within" the substrate or the source/drain regions 15. Applicants submit that this reference therefore fails to teach or suggest the claimed feature of the silicon-germanium layer being within the substrate.

Accordingly, Applicants respectfully request that the Examiner reconsider and withdraw the rejection of claims 1-3 and 8-10 under 35 U.S.C. § 103(a). Applicants respectfully submit that claims 2, 3, and 8-10 are in condition for allowance, at least by virtue of their dependency from allowable claim 1.

Rejection of Claims 12-13 and 15-16 Under 35 U.S.C. § 103(a)

In the Office Action, the Examiner rejected claims 12-13 and 15-16 under 35 U.S.C. § 103(a) as being unpatentable over *Mizushima et al.* (U.S. Patent No. 6,713,359). This rejection is respectfully traversed.

The subject matter of claim 12 is directed to a method for forming MOSFETs, comprising: providing a substrate having a source region, a gate region, and a drain region; forming, **within** the substrate, a silicon-germanium region in each of the source and drain regions and below a plane defined by an uppermost surface of the substrate; forming a silicon layer outwardly from the substrate and the silicon-germanium layer in each of the source and drain regions, the silicon layer having a thickness between approximately 25Å and 150Å; depositing a reactive metal outwardly from the silicon layer in each of the source and drain regions; reacting the reactive metal with at least a portion of the silicon layer; and selectively removing non-reacted reactive metal from the substrate to form a silicide layer in each of the source and drain regions.

It is the Examiner's position that *Mizushima et al.* show the claimed features including forming, **within** the substrate, a silicon-germanium layer (18) **in** each of the source and drain regions.

Again, it is respectfully submitted that *Mizushima et al.* entirely fail to teach or suggest this feature for the reasons set forth above. Instead, *Mizushima et al.* clearly state that the silicon-germanium layer is "on" the substrate.

Accordingly, Applicants respectfully request that the Examiner reconsider and withdraw the rejection of claims 12-13 and 15-16 under 35 U.S.C. § 103(a). Applicants

respectfully submit that claims 13, 15, and 16 are in condition for allowance, at least by virtue of their dependency from allowable claim 12.

Rejection of Claims 1 and 11 Under 35 U.S.C. § 103(a)

In the Office Action, the Examiner rejected claims 1 and 11 under 35 U.S.C. § 103(a) as being unpatentable over *Rodder et al.* (U.S. Patent No. 6,124,627) in view of *Applicant Admitted Prior Art (AAPA)*. This rejection is respectfully traversed.

The subject matter of claim 1 has been previously described and includes forming a silicon-germanium layer within said substrate in each of the source and drain regions in the substrate and below a plane defined by an uppermost surface of the substrate, the silicon-germanium layer configured to exert a compressive stress in the channel region of the substrate.

It is the Examiner's position that *Rodder et al.* show the features of claim 1, including forming a silicon-germanium layer (106a) **in** each source and drain regions by epitaxy process, referring to the Abstract, Fig. 2, col. 2, lines 48-55, col. 4, lines 23-30 thereof. The Examiner further characterize *Rodder et al.* as forming a silicon layer (106b) outwardly from the silicon-germanium layer, referring to the Abstract and Fig. 2 thereof.

To the contrary, and referring at least to those portions of *Rodder et al.* identified by the Examiner, as well as the independent claim thereof, the intent is clearly to form "a barrier layer of a raised source/drain region located over a substrate". See *Claim 1 of Rodder et al.* Thus, consistent with the Figures of *Rodder et al.*, there is no teaching or suggestion that the silicon-germanium layer is formed **in** the substrate.

Regarding the combination of *Rodder et al.* with *AAPA*, the reason *Rodder et al.* are silent as to the silicon-germanium layer exerting a compressive stress in the channel region of the substrate is due to the fact that the silicon-germanium layer is provided for an entirely different purpose in *Rodder et al.* Specifically, the silicon-germanium layer is provided as a barrier layer to prevent dopant from reaching the substrate. See col. 4, lines 43-48 of *Rodder et al.* It is respectfully submitted that the Examiner's combination of *AAPA* with *Rodder et al.* in this instance can only be based on hindsight.

Accordingly, Applicants respectfully request that the Examiner reconsider and withdraw the rejection of claims 1 and 11 under 35 U.S.C. § 103(a). Applicants respectfully submit that claim 11 is in condition for allowance, at least by virtue of its dependency from allowable claim 1.

Rejection of Claims 4-5 and 8-10 Under 35 U.S.C. § 103(a)

In the Office Action, the Examiner rejected claims 4-5 and 8-10 under 35 U.S.C. § 103(a) as being unpatentable over *Rodder et al.* (U.S. Patent No. 6,124,627) and *Applicant Admitted Prior Art (AAPA)* as applied to claims 1 and 11 and further in view of *Imai* (U.S. Patent No. 5,872,039). This rejection is respectfully traversed.

The Examiner acknowledges that the combination of *Rodder et al.* and *AAPA* are silent about the thickness of either the silicon-germanium layer or the silicon layer and that *Rodder et al.* do not specifically show the metal employed in the silicidation process. However, *Imai* is applied by the Examiner as forming a titanium silicide layer by first forming an epitaxial layer (5) having a thickness of 300 angstroms and forming a

second epitaxial layer (6) over the epitaxial layer (5) having a thickness of  $\frac{1}{2}$  (150 angstroms) to  $\frac{1}{4}$  (75 angstroms) of the thickness of the epitaxial layer (5) (col. 5, lines 45-57, col. 6, lines 20-25). Therefore, the Examiner asserts that it would have been obvious to modify *Rodder et al.* and AAPA by specifying the use of titanium and the thickness taught by *Imai* in order to ensure lateral scaling of the device while avoiding substrate consumption.

To the contrary, the thickness of the epitaxial silicon layer 5 of *Imai* is identified by the Examiner and *Imai* as 300 $\text{\AA}$ , which is well outside the claimed 25 $\text{\AA}$  to 150 $\text{\AA}$  for the silicon layer of the present invention. It is not clear why the Examiner has applied that portion of *Imai* which identifies a thickness of a polysilicon layer 6, as Applicants are not claiming such a feature. Further, the Examiner has not presented any teaching or suggestion of the claimed thickness of the silicon-germanium layer.

As stated above, *Rodder et al.* do not teach the features of claim 1 because the silicon-germanium layer associated therewith is formed over the substrate and not within the substrate as claimed. The secondary references do not overcome the missing teachings of *Rodder et al.*, taken either singly or in combination for the reasons set forth above. Therefore, claims 4-5 and 8-10 are also non-obvious over the applied references.

Accordingly, Applicants respectfully request that the Examiner reconsider and withdraw the rejection of claims 4-5 and 8-10 under 35 U.S.C. § 103(a). Applicants respectfully submit that claims 4-5 and 8-10 are further in condition for allowance, at least by virtue of their dependency from allowable claim 1.

Rejection of Claims 12-16 Under 35 U.S.C. § 103(a)

In the Office Action, the Examiner rejected claims 12-16 under 35 U.S.C. § 103(a) as being unpatentable over *Rodder et al.* (U.S. Patent No. 6,124,627) in view of *Imai* (U.S. Patent No. 5,872,039). This rejection is respectfully traversed.

The subject matter of claim 12 is directed to forming, within the substrate, a silicon-germanium region in each of the source and drain regions and below a plane defined by an uppermost surface of the substrate.

To the contrary and as previously explained in detail, *Rodder et al.* fail to teach or suggest this feature and instead form a silicon-germanium layer **over** the substrate. Further, *Imai* fail to meet the identified limitation above and also fail to teach or suggest the claimed thicknesses of the silicon layer or the silicon-germanium layer as previously explained.

Accordingly, Applicants respectfully request that the Examiner reconsider and withdraw the rejection of claims 12-16 under 35 U.S.C. § 103(a). Applicants respectfully submit that claims 13-16 are in condition for allowance, at least by virtue of their dependency from allowable claim 12.

**CONCLUSION**

In view of the foregoing remarks, Applicants submit that this claimed invention is neither anticipated nor rendered obvious in view of the prior art references applied against this application. Applicants therefore request the Examiner's reconsideration and reexamination of the application, and the timely allowance of the pending claims.

Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 20-0668.

Respectfully submitted,

Dated: October 4, 2006

By:   
Barbara A. Fisher  
Reg. No. 31,906

Timothy M. Hsieh  
Reg. No. 42,672

MIN, HSIEH & HACK LLP  
703.917.0000